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RADAR APPROACH CONTROL (RAPCON) PRIMARY INPUT POWER SUPPLY STUD--ETC(U)

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UNCLASSIFIED 1842 EEG/EEISG-TR-79-15 NL

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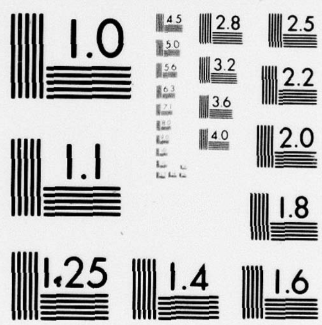

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1842 EEG/EEISG TR 79-15

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AFCS TECHNICAL REPORT

RADAR APPROACH CONTROL (RAPCON) PRIMARY INPUT POWER SUPPLY STUDY

SUPPORT ENGINEERING BRANCH (EEIS)
1842 ELECTRONICS ENGINEERING GROUP (AFCS)
SCOTT AIR FORCE BASE, IL 62225

15 AUG 1979

1842 ELECTRONICS ENGINEERING GROUP

MISSION

The 1842 Electronics Engineering Group (EEG) has the mission to provide communications-electronics-meteorological (CEM) systems engineering and consultive engineering support for AFCS. In this respect, 1842 EEG responsibilities include: Developing engineering and installation standards for use in planning, programming, procuring, engineering, installing and testing CEM systems, facilities and equipment; performing systems engineering of CEM requirements that must operate as a system or in a system environment; operating a specialized Digital Network System Facility to analyze and evaluate new digital technology for application to the Defense Communications System (DCS) and other special purpose systems; operating a facility to prototype systems and equipment configurations to check out and validate engineering-installation standards and new installation techniques; providing consultive CEM engineering assistance to HQ AFCS, AFCS Areas, MAJCOMS, DOD and other government agencies.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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This study compiles the findings, conclusions and recommendations of the 1842 EEG regarding RAPCON equipment failures.

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APPROVAL PAGE

This report has been reviewed and is approved for publication and distribution.

Gerald T. Harris

GERALD T. HARRIS
1842 EEG/EEI
Chief, Electronics/Base Systems Engineering Division

Leo W. Dlugolecki

LEO W. DLUGOLECKI
1842 EEG/EEIS
Chief, Support Engineering Branch

John F. Zych

JOHN F. ZYCH
1842 EEG/EEISG
Technical Area Manager

Robert L. Boyce

ROBERT L. BOYCE, AUTHOR
1842 EEG/EEISG
Electrical Engineer

ABSTRACT

This report compiles the findings, conclusions and recommendations of the 1842 EEG regarding RAPCON equipment failures. The findings and conclusions are based upon the following:

a. Several input power surveys made to determine the possible effect of voltage fluctuations causing equipment failure.

b. Would the use of power line voltage regulators on the equipment supply circuits correct the equipment failures. Failure data was collected from 52 sites (with and without voltage regulators.)

Recommendations include:

a. Transient protection criteria to be included in equipment specifications.

b. Installation data on protective devices.

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1.0 BACKGROUND.

1.1 This study was requested by the TRACALS/Electronics Systems Branch, 1842 EEG (AFCS) in response to Tactical Communication Area (TACCA) units encountering RAPCON equipment failure. TACCA stated the equipment failures were due to AC power surges and requested that all AC power to RAPCON facilities and equipments be provided with voltage regulators and/or uninterruptible power systems, thus concluding that this action would correct equipment failure problems.

1.2 Equipment failure data was collected from 52 representative sites (with and without voltage regulators) for a period of 12 months. This was done to determine whether or not equipment failures were less while using voltage regulators on RAPCON AC power supplies.

2.0 FINDINGS.

2.1 No correlation could be found between reduced failures and the use of voltage regulators. The equipment failure rates at sites with regulated power supplies, compared to those sites with unregulated power supplies were approximately the same, except that indicator scopes located at sites with unregulated power supply systems had a lower failure rate.

2.2 It was also found that seven of the ten highest failure incidence sites had regulated input power.

2.3 Failure rates were found to be at, or below, the specified "mean time between failure" (MTBF) of the equipment.

3.0 DIAGNOSIS OF FINDINGS.

3.1 Accumulated data indicated that the lack of power line voltage regulators was not the cause of RAPCON equipment failures. Based on this premise, a test plan was initiated to monitor the characteristics of the AC power sources supplying the RAPCONs. The following parameters were recorded:

a. Frequency - 60 Hz (variations greater than $\pm$ 0.5 Hz.

b. RMS Amplitudes - less than 115 volts

c. RMS Amplitudes - greater than 125 volts

d. Impulses - greater than 50 volts

e. Impulses - greater than 300 volts

Note: Only impulses with a rise time of greater than 0.5 microsecond and 250 millisecond separation were recorded.

3.2 Six sites with a high rate of equipment failure were selected for this test. Monitoring at each site was conducted for a minimum period of 48 hours. The results of this test indicated that some power line transients occurred which were inherent to power source changeover (switching to backup generators) and the cycling of heavy electrical loads, such as the starting of air conditioners.

4.0 CONCLUSIONS.

4.1 Study results show that line voltage regulators are not a cure-all "fix" to reduce equipment failures, since they will not eliminate all transients. No correlation was found between reduced failures and the use of voltage regulators.

4.2 The primary power sources tested during this study showed that: (1) RMS voltage and frequency variations recorded were not significant enough to cause equipment damage, and (2) those impulses which were recorded could be inherent to power source changeovers and the cycling of electrical loads.

4.3 Concerning backup power sources: (1) Voltage and frequency variations were recorded at some test sites which were beyond the tolerance of the electronic equipment, (2) the cause of these variations was due to malfunction of the prime movers.

4.4 Failure rates of the electronic equipment were at or below the specified MTBF.

5.0 RECOMMENDATIONS.

5.1 New Procurements and Modified Equipment.

5.1.1 Specify protection to prevent equipment damage as a result of transients that may be conducted into the equipment through power, control and communication lines; after having been induced onto the lines by manmade sources, such as heavy switching transients or by natural phenomena such as lightning. Transient protection to protect against pulses having the following characteristics:

Peak Voltage	Pulse Rate	Pulse Width (Microseconds)	Rise Time (Microseconds)	Decay Time (Microseconds)	Approx Energy (Joules)
1000	Single Pulse	1000	10	1000	33
1000	100 per sec.	1000	1	100	3.3

5.1.2 It should be specified that all equipment will operate within the power parameters of MIL-E-4158, Table II, parts "A and B" with conditions I, II, III and IV enforced.

5.1.3 The equipment should also be operated and tested in accordance with the power parameters of para 5.1.2 above.

5.2 Existing Equipment and Facilities

5.2.1 For locations having a high incidence of equipment failures, impulse suppressors should be installed onto the equipment power distribution panels. For example, the metal oxide varistor (MOV) is a versatile low cost (six to fifteen dollars per panel) suppression device. Catalog information and installation instructions are included in Appendix A.

5.2.2 It is also recommended that an assessment in terms of improved operation and reduction of failures be made at locations protected by MOV's. For those locations where failure rates remain unchanged, it is recommeded that suppression devices be installed on control and communication lines.

REFERENCES:

"GE-MOV Varistors Voltage Transient Suppressors"; General Electric Semiconductor Products Department.

APPENDIX A

INSTALLATION INSTRUCTIONS FOR METAL OXIDE VARISTORS (MOV'S)

I. GENERAL INFORMATION.

The following instructions provides for the installation of metal oxide varistors (MOV's) which may be used to protect electronic equipment from power line transients. Figure 1 shows a typical one line electrical diagram and the various locations for installing the MOV's in the power distribution system. The most effective location for installing MOV's is the equipment power panel which directly serves the 120/208V equipment branch circuits. Installation of the MOV's within these panels provides the maximum protection against transients whether they originate in the power source or from other electronic equipment. Additional protection from source generated transients may be obtained by installing MOV's "upstream" in the power distribution system. For example, MOV's in a main 208/120V distribution panel or, if available, in a 480V distribution system will suppress severe transients originating on the utility power line or other facility loads.

II. SELECTING THE MOV TYPE AND RATING.

MOV's are available in two basic configurations for power distribution applications. These are designated as the series LA and the series PA. The physical description and electronic characteristcs of each type are provided in this Appendix.

The series LA is recommended for power panels housing branch circuit breakers and the 120/280V main distribution panels. The series PA is recommended for distribution buses upstream from branch circuit panel boards. For most applications the following MOV model numbers are recommended:

480 System	General Electric	#V320PA40C
120/208V Main Distribution Panel	General Electric	#V130PA20C
120/208V Distribution Panel	General Electric	#V130LA20B
120/208V Power Panels	General Electric	#V130LA20B

If the system distribution voltage is different from 120/208V or 480/277V, refer to rating tables to select the MOV with the proper RMS steady state line to ground voltage. In selecting the MOV voltage rating for a location where the voltage is poorly controlled and can exceed the maximum rating (130, 150, 250, 275, 320, 420 . . . etc.) for more than several seconds, then the MOV with next higher AC voltage rating should be chosen. Otherwise, the MOV may pass excessive current and burn up.

10

MOV's are available in various joule (energy) ratings and clamping levels. These characteristics are specified in the MOV model number as shown:

	Type		Clamping Level
V130	LA	20	B
Voltage rating		Joule rating	

It is recommended that the largest joule rating and lowest clamping level available for a specified voltage rating be selected. In almost all cases, clamping level B should be selected for the series LA MOV's and clamping level C should be selected for the series PA MOV's.

III. INSTALLATION OF SERIES LA MOV's IN BRANCH CIRCUIT PANEL BOARDS

The series LA MOV's are installed from phase to ground in branch circuit panels. Figure 2 is provided to illustrate this installation. Specific installation procedures are as follows:

1. Remove panel and breaker cover.

2. Locate circuit breaker for MOV's as near to the ground bus as possible. Single pole breakers can be used for multiphase provided they are located adjacent to one another. (See note below)

3. De-energize the MOV breaker plus several other adjacent breakers for safety.

4. Solder appropriate terminal connectors onto one of the leads of each MOV for connection to the circuit breaker.

5. Solder the other lead of each MOV to a green grounding conductor, @12AWG so lid copper.

6. Connect the MOV line terminals to the breaker. Connect the green grounding conductor to the ground bus of the panel. This grounding conductor should be as short as possible.

7. Test that these MOV's are not defective by turning on breaker prior to replacing panel cover.

8. Replace breaker cover and panel cover.

NOTE: IF SPARE BREAKERS ARE NOT AVAILABLE OR SPACE IS NOT AVAILABLE FOR AN ADDITIONAL BREAKER, THEN THE MOV's CAN BE INSTALLED IN SERIES WITH 10 AMP FUSES AS ILLUSTRATED IN FIGURE 3.

IV. INSTALLATION OF SERIES LA MOV's WITH FUSES. WHERE CIRCUIT BREAKERS DO NOT EXIST AND CANNOT BE ADDED.

The series LA MOV's are installed from phase to ground. Figure 3 is provided to illustrate this installation with fuses for protection. Specific installation procedures are as follows:

1. De-energize panelboard.

2. Remove panel cover and breaker cover.

3. Measure panel bus voltage to insure power is disconnected.

4. Remove circuit breakers as required to gain access to the bus bars.

5. Drill and bevel holes into bus bars. Provide countersunk screws which, when mounted, will be flush with the bus bar and will not interfere with circuit breakers.

6. Provide a separate Nema 1 enclosure with a clear plastic cover of sufficient size to contain the MOV's and the fuse block. For three phase systems, the fuse block should contain three fuse clips to hold three of the 10Amp, glass tube type fast acting fuses. Mount fuse block in enclosure. Fuse clip terminals can be either solder or screw type.

7. Locate the Nema 1 enclosure onto the main distribution panel such that conductor lengths to the bus bars and the grounding bus will be minimal. Fasten the enclosure with a nipple, locknuts and busings. Insure that the location selected will not interfere with enclosure covers.

8. Solder one of the leads of each MOV to a green grounding conductor, #12AWG solid copper. Connect the green grounding conductor to the ground bus #12AWG solid copper. Connect the green grounding conductor to the ground bus of the panel. The green grounding conductor should be as short as possible.

9. Solder appropiate terminal connectors onto the other lead of each MOV and connect to the fuse clip terminals.

10. Provide three #14 AWG conductors of sufficient length to reach from each bus bar to each fuse terminal. Solder appropriate terminal connectors on each end of each wire. Connect one end of each wire to the rear of the bus bar and fasten it with a lockwasher and nut. Connect the other end to the fuse terminal as shown in Figure 3.

11. Insure all wire lengths are as short as possible.

12. Replace breakers, breaker covers, panel cover, and install enclosure cover.

13. Re-energize panelboard, check MOV's and fuses.

V. INSTALLATION OF SERIES PA MOV's IN DISTRIBUTION SYSTEM AHEAD OF THOSE PANELS WHERE SERIES LA MOV's ARE INSTALLED.

The series PA MOV's are installed from phase to ground. Figure 4 is provided to illustrate this installation. Specific installation procedures are as follows:

1. Select location for installing MOV's. The location might be the secondary of a transformer, switchgear or the load side of a transfer switch.

2. De-energize equipment in which MOV's are to be installed.

3. Measure bus voltage to insure power is disconnected.

4. Drill holes into bus bars. Provide hex bolts, lock washers and nuts for connection of conductors.

5. Provide a separate Nema 1 enclosure with a clear plastic cover of sufficient size to contain the MOV's fuse block. The fuse block should contain three fuse clips to hold three of the 10Amp glass tube type fast acting fuses. Fuse clip terminals can be either the solder or screw type. Spot and drill holes for mounting the fuse block.

6. Spot three PA series MOV's within the enclosure using screws, lock-washers and nuts. Mount the fuse block.

7. Locate the Nema 1 enclosure onto the equipment such that conductor lengths to the bus bars and the grounding bus will be minimal. Fasten the enclosure with a nipple, locknuts and bushings. Insure that the location selected will not interfere with enclosure covers.

8. Prepare three #14 conductors with a male 1/4" quick connect terminal on one end and a solder lug for screw connection (if fuse block has screw terminals) on the other end. Solder all terminals to wire leads cut to minimize connection lengths from MOV's to fuses. Install leads on MOV's by pushing the quick connect terminal onto the MOV terminal and then screwing or soldering the other ends of the wire leads to the fuse terminals.

9. Connect one end of a green grounding conductor, #12AWG solid copper, under one mounting screw of each MOV. Connect the other end to the grounding bus.

10. Provide three #14AWG copper conductors of sufficient length to reach from each bus connection to the fuse block. Solder appropriate terminal connectors on each end of each wire. Connect one end of each wire to the bus bar with hex bolt and the other end to the respective fuse terminal as shown in Figure 4.

11. Insure all wire lengths are as short as possible.

12. Replace all panel and enclosure covers.

13. Re-energize distribution, check MOV's and fuses.

VI. MAINTENANCE OF SERIES LA AND SERIES PA MOV INSTALLATIONS

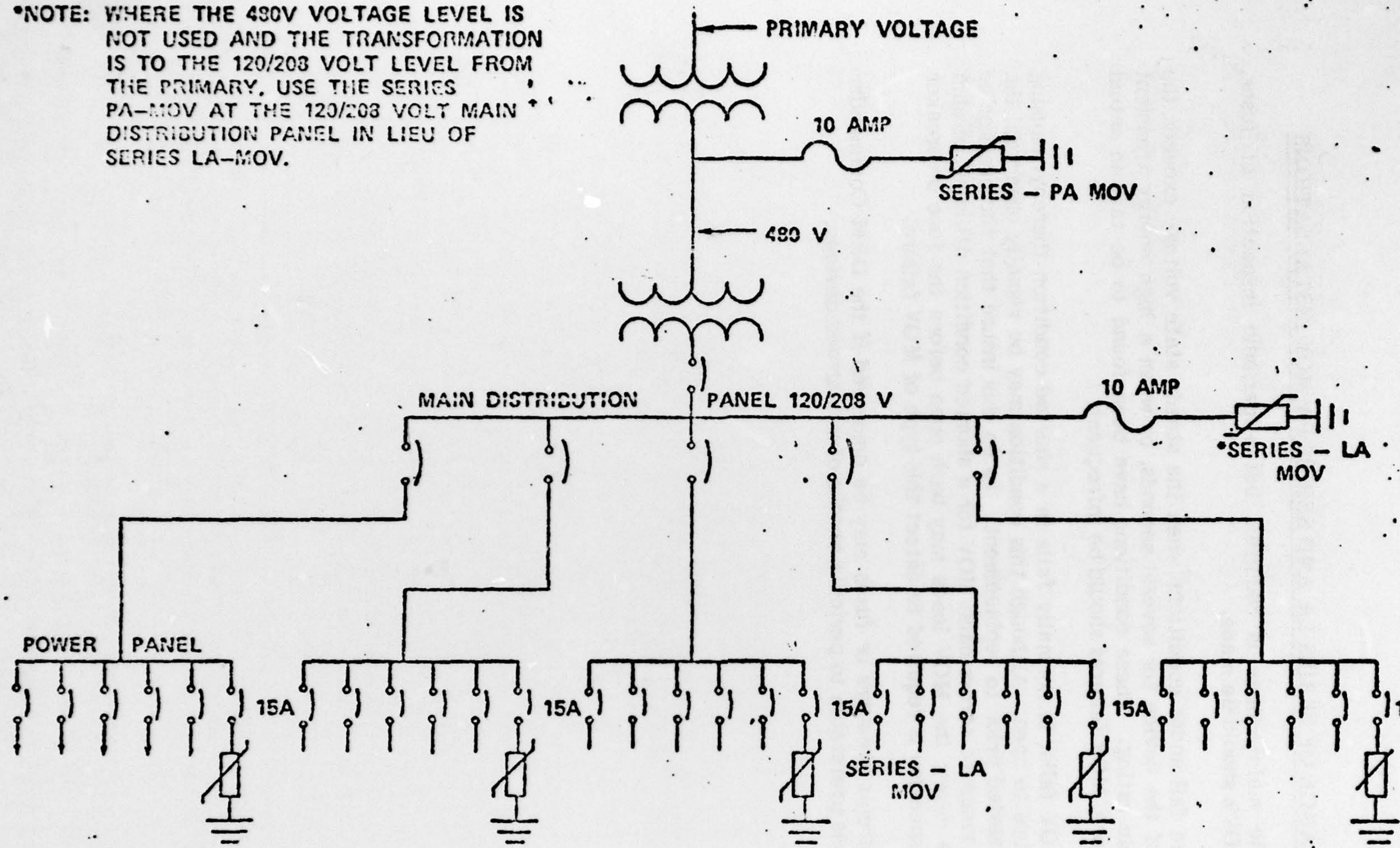
No specific maintenance is required, but a periodic inspection of fuses, breakers, and MOV's should be made.

A MOV can fail under conditions when the steady state voltage exceeds the voltage rating of the device for several seconds, or when a high energy transient exceeds the joule rating. These conditions have been found to be rare in actual practice; therefore, MOV failures should be infrequent.

When a MOV fails, it normally fails in a shorted condition thereby, causing the breaker or fuse to open. Although this condition may be visually observed, the MOV should be tested prior to replacement. To do this insure that the breaker or fuse is open and measure across each MOV for a shorted condition utilizing an ohm meter. In some cases, the MOV leads may burn open before the fuse or breaker opens. Visual inspection is required to detect this type of MOV failure.

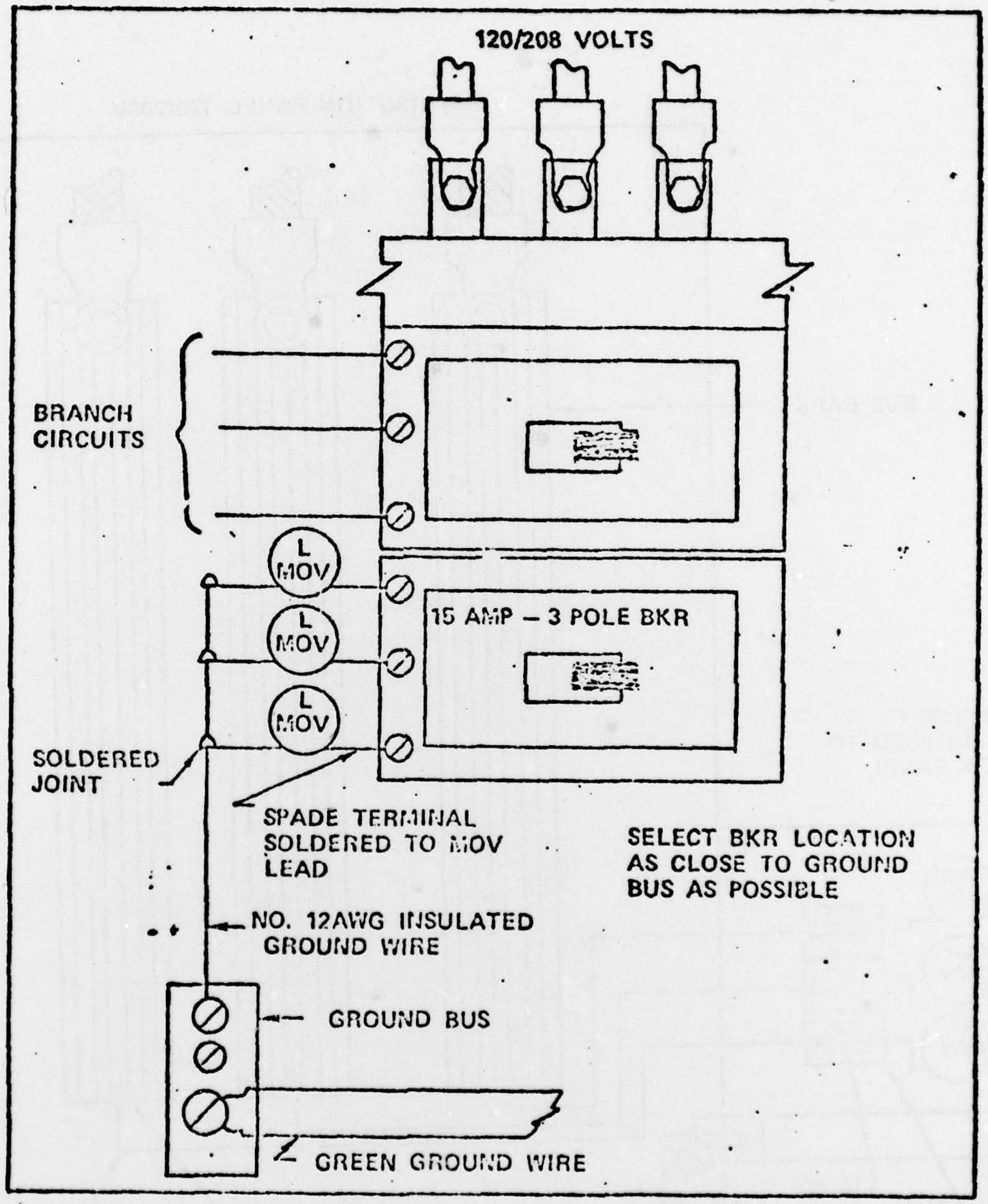
Alarmed circuit breakers or fuses may be employed if the O&M Commander considers their use preferable to periodic checks of unalarmed devices.

*NOTE: WHERE THE 480V VOLTAGE LEVEL IS NOT USED AND THE TRANSFORMATION IS TO THE 120/208 VOLT LEVEL FROM THE PRIMARY, USE THE SERIES PA–MOV AT THE 120/208 VOLT MAIN DISTRIBUTION PANEL IN LIEU OF SERIES LA–MOV.



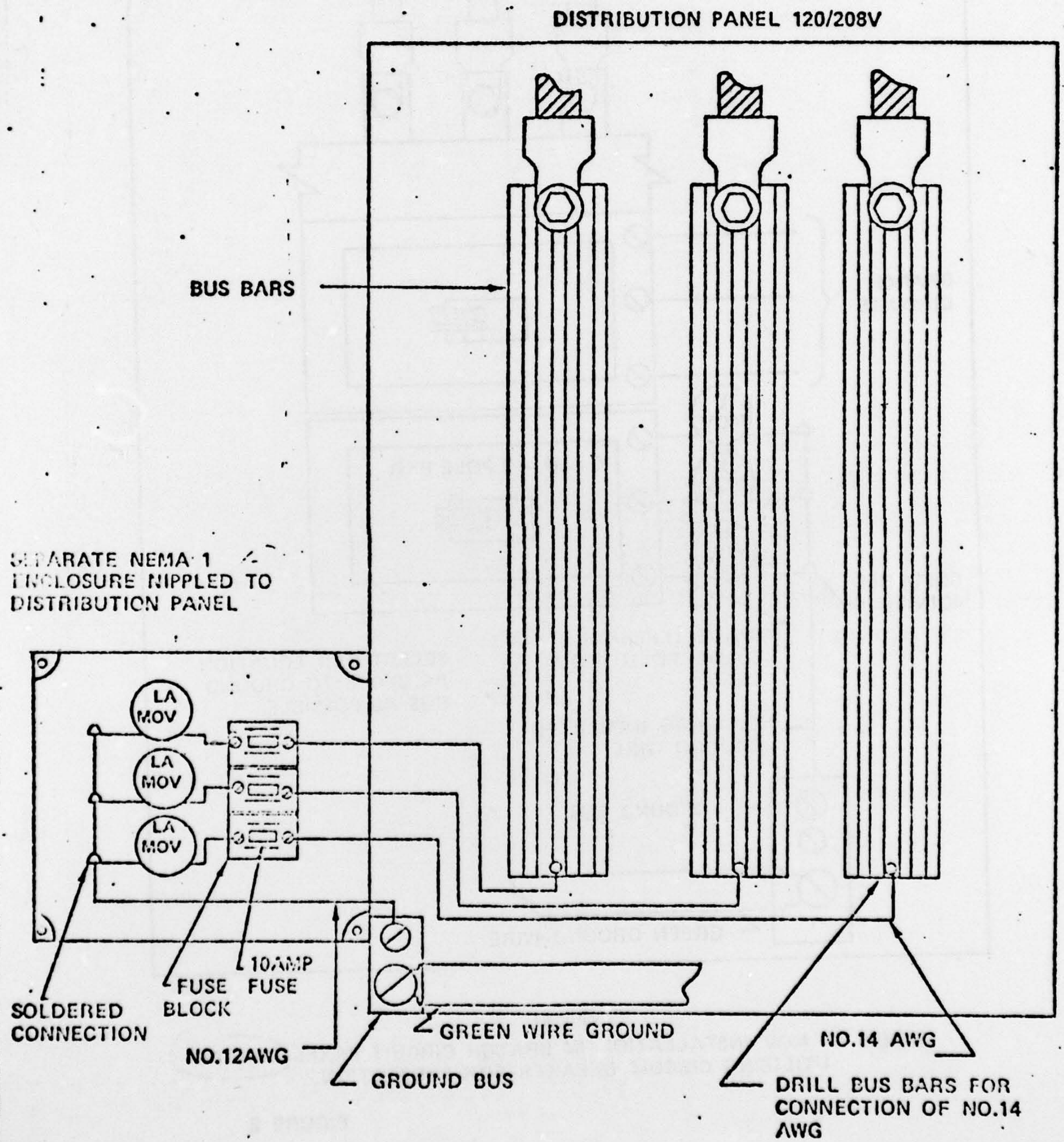
MOV INSTALLATION LOCATIONS

FIGURE 1



TYPICAL
SERIES LA MOV INSTALLATION IN BRANCH CIRCUIT PANEL BOARDS
UTILIZING CIRCUIT BREAKER FOR PROTECTION.

FIGURE 2

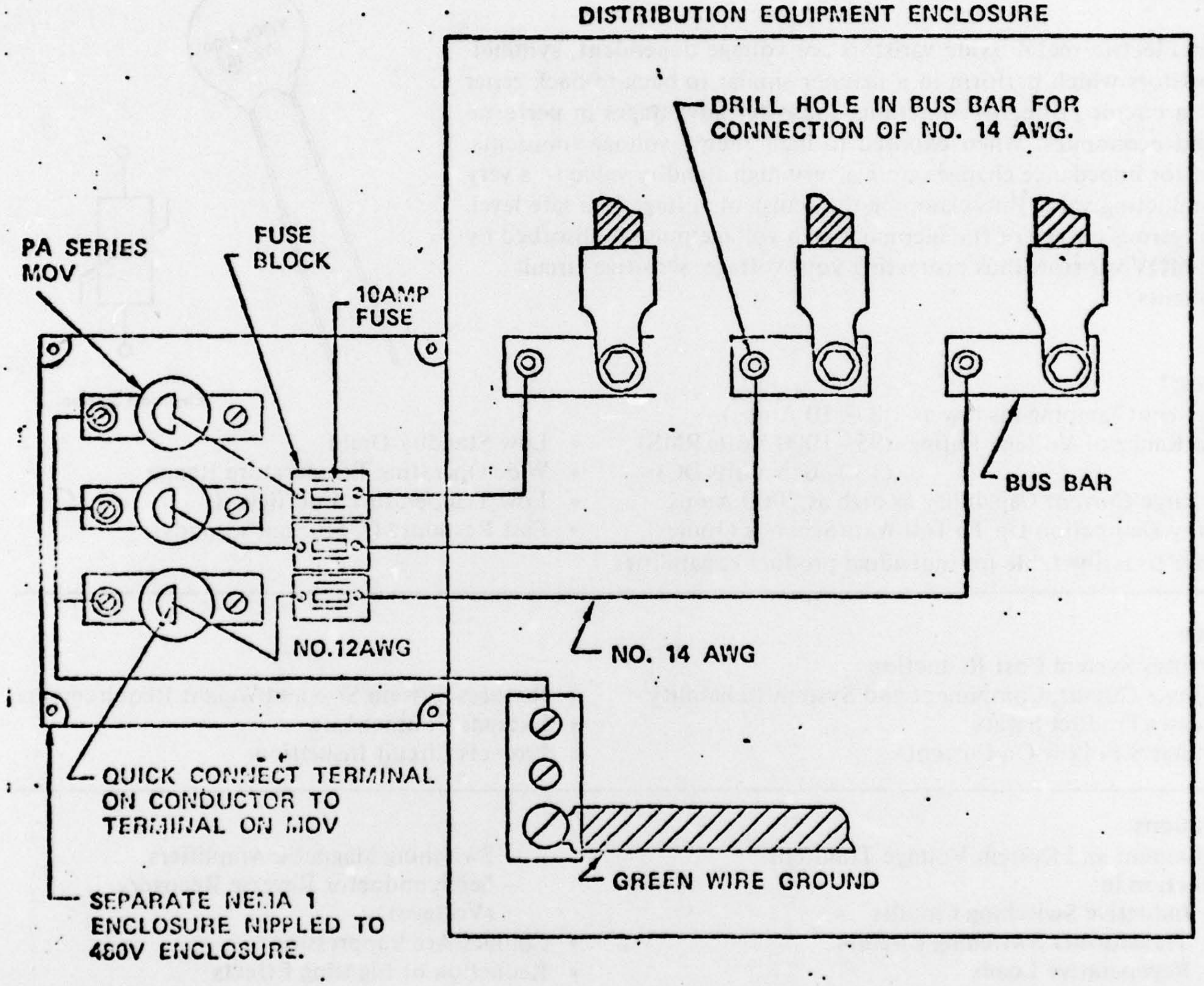


CAUTION: MEASURE PANEL VOLTAGE TO INSURE POWER IS DISCONNECTED PRIOR TO INSTALLATION.

TYPICAL
SERIES LA MOV INSTALLATION WITH FUSES FOR PROTECTION.

FIGURE 3

CAUTION: MEASURE EQUIPMENT BUS VOLTAGE TO INSURE POWER IS DISCONNECTED PRIOR TO INSTALLATION.



TYPICAL

SERIES PA MOV INSTALLATION IN DISTRIBUTION EQUIPMENT

FIGURE 4

INNOVATIONS IN ACTION

GE-MOV™

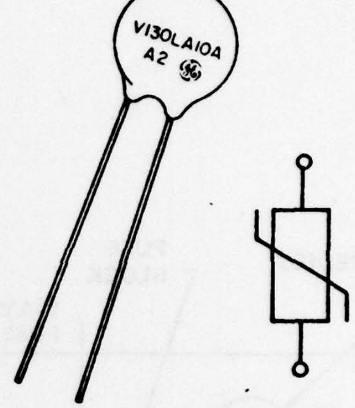
Metal Oxide Varistors

95-1000 Volts RMS AC   130-675 Volts DC

GE-MOV™ VARISTOR SERIES

Description:

General Electric metal oxide varistors are voltage dependent, symmetrical resistors which perform in a manner similar to back-to-back zener diodes in circuit protective functions and offer advantages in performance and economics. When exposed to high energy voltage transients, the varistor impedance changes from a very high standby value to a very low conducting value thus clamping the transient voltage to a safe level. The dangerous energy of the incoming high voltage pulse is absorbed by the GE-MOV varistor, thus protecting your voltage sensitive circuit components.



Electrical Symbol

Features:*

- Excellent Clamping (as low as 1.8 @ 10 Amps)
- Wide Range of Voltage Ratings (95–1000 Volts RMS) (130–675 Volts DC)
- Discharge Current Capability as high as 2000 Amps
- Energy Dissipation Up To 160 Watt-Seconds (Joules)
- Low Standby Drain
- Wide Operating Temperature Range
- Low Temperature Coefficient
- Fast Response (< 50 Nanoseconds)

*Refer to rating table for individual product capabilities.

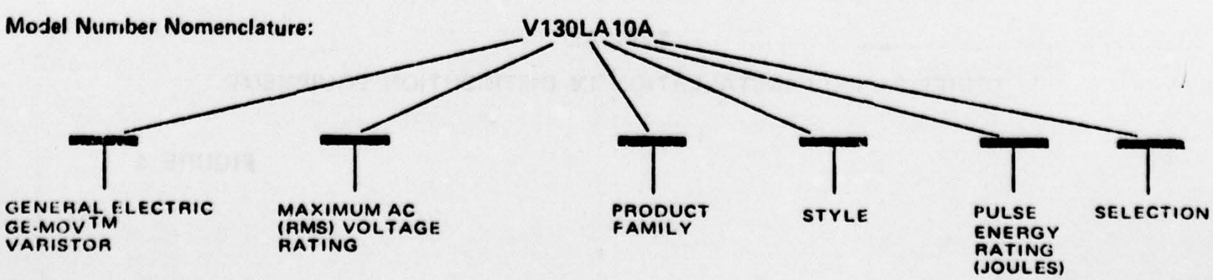
Benefits:

- Promotes System Cost Reduction
- Improves Circuit, Component and System Reliability
- Increases Product Safety
- Eliminates Follow-On Current
- Reduces System Size and Weight Requirements
- Extends Contact Life
- Protects Circuit Insulation

Applications:

- Component and System Voltage Transient Protection in:
  - Inductive Switching Circuits
  - Transformer Switching Circuits
  - Regenerative Loads
  - Switching Magnetic Amplifiers
  - Semiconductor Reverse Recovery (Voltage)
- Contact Arc Suppression
- Reduction of Lighting Effects

Model Number Nomenclature:

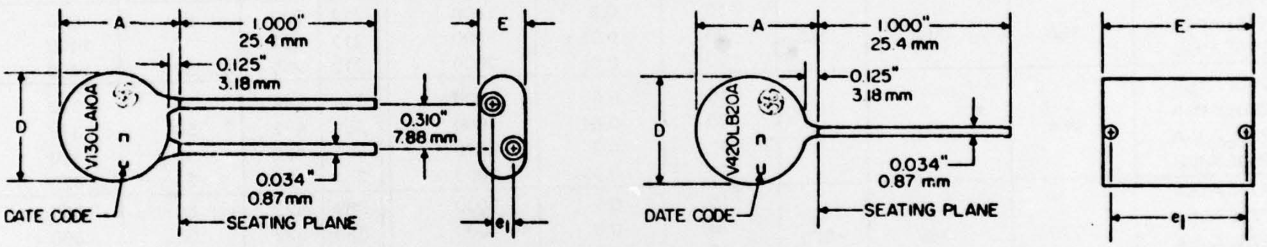


Maximum Electrical Ratings:

Maximum Energy, Power and Peak Current . . . . See Rating Table
Storage Temperature, T_{STG} . . . . −40°C to +125°C
Operating Surface Temperature, T_S . . . . 115°C
Operating Ambient Temperature (without derating) . . . . 85°C
Maximum Voltage Temperature Coefficient . . . . −0.05%/°C

Mechanical Ratings:

Insulation Resistance – Megohms . . . . >1000
Hipot Encapsulation – Volts D.C. for 1 Minute 2500
Solderability . . . . Per Mil Std 202D Method 208B



MODEL	A MAX. IN.	A MAX. MM	D MAX. IN.	D MAX. MM	E MAX. IN.	E MAX. MM	e1 MAX. IN.	e1 MAX. MM
V95LA7	.745	18.93	.620	15.75	.230	5.85	.110	2.80
V130LA10	.745	18.93	.620	15.75	.230	5.85	.110	2.80
V130LA20	1.005	25.53	.880	22.36	.230	5.85	.170	4.32
V150LA10	.745	18.93	.620	15.75	.230	5.85	.110	2.80
V150LA20	1.005	25.53	.880	22.36	.230	5.85	.170	4.32
V250LA15	.745	18.93	.620	15.75	.290	7.37	.170	4.32
V250LA20	.745	18.93	.620	15.75	.290	7.37	.170	4.32
V250LA40	1.005	25.53	.880	22.36	.290	7.37	.180	4.58
V275LA15	.745	18.93	.620	15.75	.290	7.37	.170	4.32
V275LA20	.745	18.93	.620	15.75	.290	7.37	.170	4.32
V275LA40	1.005	25.53	.880	22.36	.290	7.37	.180	4.58

NOTE:
1) Lead spacing dimensions as measured within 0.050 inches (1.27 mm) of seating plane
2) All dimensions shown are maximums except lead length which is a minimum

MODEL	A MAX. IN.	A MAX. MM	D MAX. IN.	D MAX. MM	E MAX. IN.	E MAX. MM	e1 MAX. IN.	e1 MAX. MM
V420LB20	.745	18.93	.620	15.75	.395	10.04	.345	8.76
V420LB40	.745	18.93	.880	22.36	.395	10.04	.370	9.40
V460LB20	.745	18.93	.620	15.75	.395	10.04	.345	8.76
V460LB40	1.005	25.53	.880	22.36	.395	10.04	.370	9.40
V480LB20	.745	18.93	.620	15.75	.395	10.04	.345	8.76
V480LB40	.745	18.93	.620	15.75	.395	10.04	.345	8.76
V480LB80	1.005	25.53	.880	22.36	.395	10.04	.370	9.40
V510LB20	.745	18.93	.620	15.75	.395	10.04	.345	8.76
V510LB40	.745	18.93	.620	15.75	.395	10.04	.345	8.76
V510LB80	1.005	25.53	.880	22.36	.395	10.04	.370	9.40
V550LB20	.745	18.93	.620	15.75	.700	17.78	.615	15.63
V550LB40	.745	18.93	.620	15.75	.700	17.78	.615	15.63
V550LB80	1.005	25.53	.880	22.36	.750	19.05	.640	16.26
V575LB20	.745	18.93	.620	15.75	.700	17.78	.615	15.63
V575LB40	.745	18.93	.620	15.75	.700	17.78	.615	15.63
V575LB80	1.005	25.53	.880	22.36	.750	19.05	.640	16.26
V1000LB80	.745	18.93	.620	15.75	.700	17.78	.615	15.63
V1000LB160	1.005	25.53	.880	22.36	.750	19.05	.640	16.26

FIGURE 1. DIMENSION TABLE

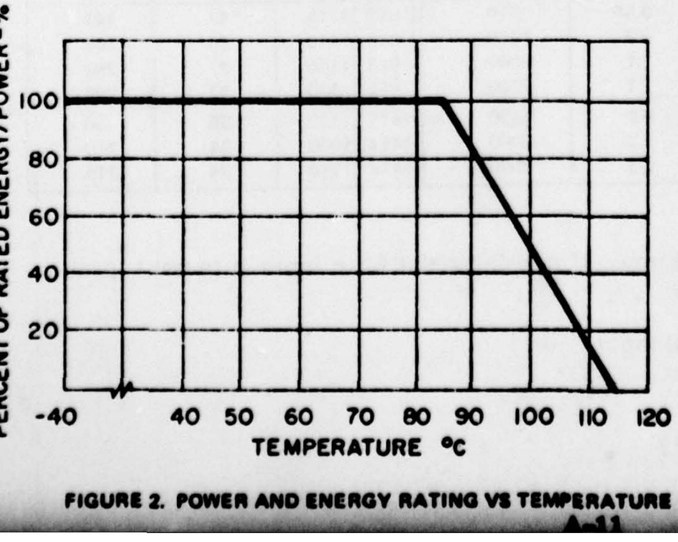


FIGURE 2. POWER AND ENERGY RATING VS TEMPERATURE

The average power input over the periodic time base resulting from successive voltage transients must be equal to, or less than, the GE-MOV varistor's rated average power dissipation at the specified ambient temperature! When this condition is met, the selected GE-MOV varistor has an energy rating high enough to suppress a voltage transient of the specified energy level at its operating surface temperature.

1. For higher average power dissipation, refer to General Electric's Power-MOV™ Varistor Series. Publication #180.67 3/73.

MAXIMUM RATINGS: **CHARACTERISTICS:**

Model Number	RMS (1) Applied Voltage	Recurrent (1) Peak Idle Voltage	DC Applied Voltage	Energy (2)	Average (2) Power Dissipation	Peak Current For $t_p < 6$ us	Varistor (3) Peak Voltage @ 1 mA A.C. Peak		Maximum Thermal Resistance Body to Air	Typical Capacitance
							Min.	Max.		
	Volts	Volts	Volts	Joules	Watts	Amperes	Volts	Volts	°C/W	Picofarads
V95LA7A	95	134	130	7	0.45	1000	134	207	67	1050
V95LA7B				7	0.45	1000	134	170	67	1050
V130LA10A				10	0.5	1000	184	254	60	700
V130LA20A	130	184	175	20	0.85	2000	184	254	37	1500
V130LA20B				20	0.85	2000	184	238	37	1500
V150LA10A				10	0.5	1000	212	282	60	640
V150LA20A	150	212	200	20	0.85	2000	212	282	37	1400
V150LA20B				20	0.85	2000	212	255	37	1400
V250LA15A				15	0.6	1000	354	472	50	375
V250LA20A	250	354	330	20	0.6	1000	354	472	50	375
V250LA40A				40	0.9	2000	354	472	35	820
V250LA40B				40	0.9	2000	354	428	35	820
V275LA15A				15	0.6	1000	389	522	50	360
V275LA20A	275	389	369	20	0.6	1000	389	522	50	360
V275LA40A				40	0.9	2000	389	522	35	780
V275LA40B				40	0.9	2000	389	495	35	780
V420LB20A			–(4)	20	0.55	1000	595	800	55	225
V420LB40A	420	595	560	40	0.9	2000	595	800	35	490
V420LB40B			560	40	0.9	2000	595	752	35	490
V460LB20A			–(4)	20	0.55	1000	650	878	55	210
V460LB40A	460	650	615	40	0.9	2000	650	878	35	460
V460LB40B			615	40	0.9	2000	650	800	35	460
V480LB20A			–(4)	20	0.55	570	679	914	55	195
V480LB40A	480	679	–(4)	40	0.7	1000	679	914	45	195
V480LB80A			640	80	1.0	2000	679	914	30	430
V480LB80B			640	80	1.0	2000	679	878	30	430
V510LB20A			–(4)	20	0.55	570	721	970	55	185
V510LB40A	510	721	–(4)	40	0.7	1000	721	970	45	185
V510LB80A			675	80	1.0	2000	721	970	30	405
V510LB80B			675	80	1.0	2000	721	914	30	405
V550LB20A				20	0.6	570	778	1060	50	175
V550LB40A	550	778	–(4)	40	0.7	1000	778	1060	45	175
V550LB80A				80	1.0	2000	778	1060	30	390
V550LB80B				80	1.0	2000	778	963	30	390
V575LB20A				20	0.65	570	813	1115	47	165
V575LB40A	575	813	–(4)	40	0.8	1000	813	1115	36	165
V575LB80A				80	1.1	2000	813	1115	27	365
V575LB80B				80	1.1	2000	813	970	27	365
V1000LB80A				80	0.9	1000	1414	1900	35	90
V1000LB160A	1000	1414	–(4)	160	1.3	2000	1414	1900	24	210
V1000LB160B				160	1.3	2000	1414	1750	24	210

NOTES:

(1) Sinusoidal voltage assumed as normal input conditions. If nonsinusoidal wave input is present, peak voltage input values should be used to select model.

(2) See Figure 2.

(3) 1 mA standby current based upon 60 HZ sinusoidal input.

(4) Not recommended due to high power dissipation.

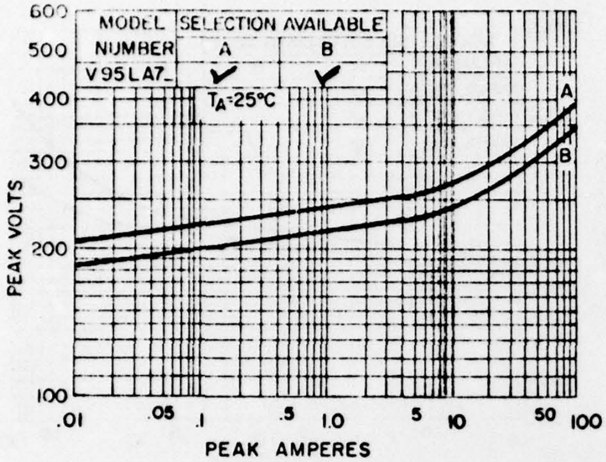


FIGURE 3. 95 VRMS PRODUCT

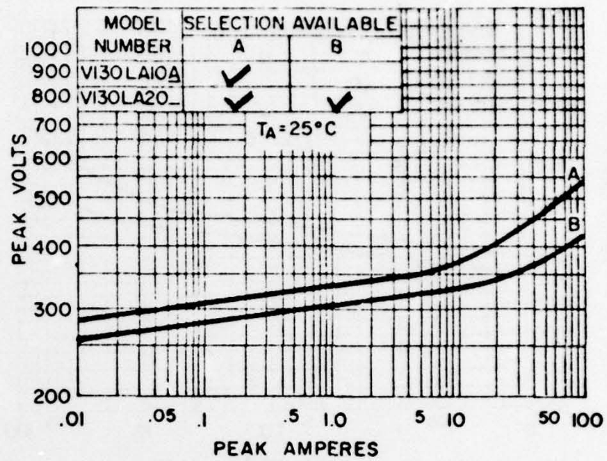


FIGURE 4. 130 VRMS PRODUCT

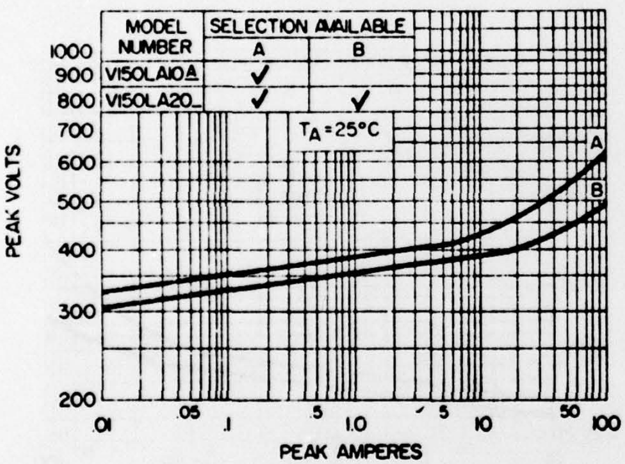


FIGURE 5. 150 VRMS PRODUCT

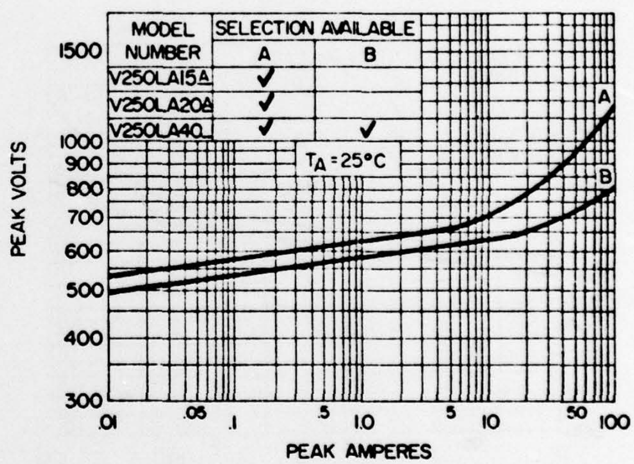


FIGURE 6. 250 VRMS PRODUCT

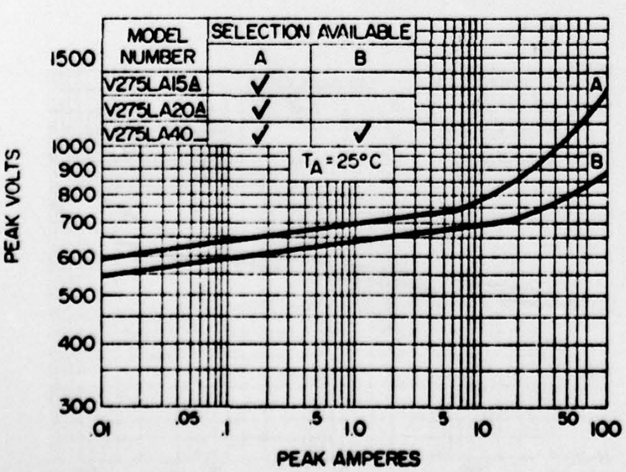


FIGURE 7. 275 VRMS PRODUCT

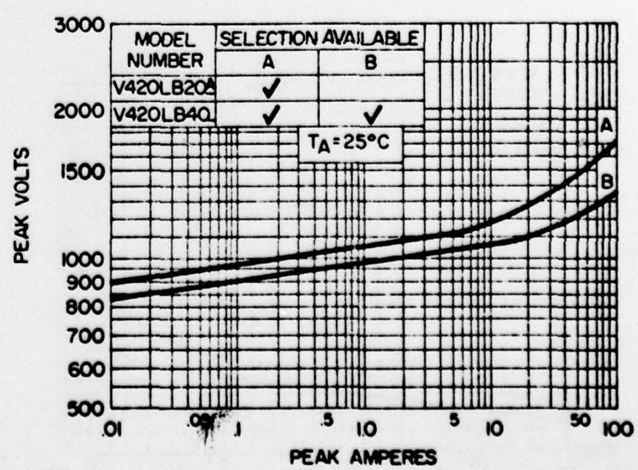


FIGURE 8. 420 VRMS PRODUCT

Maximum Volt–Ampere Characteristics:

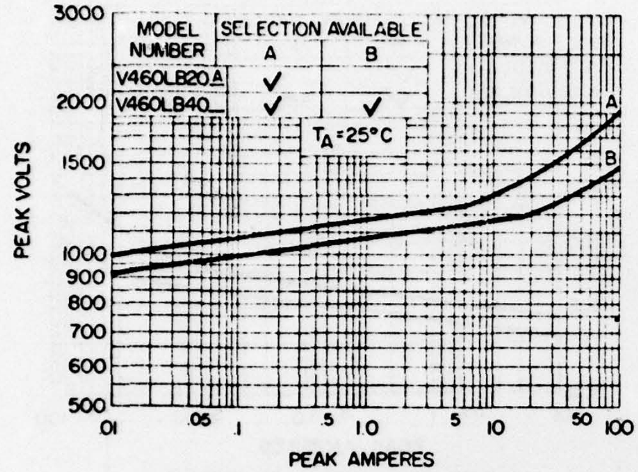


FIGURE 9. 460 VRMS PRODUCT

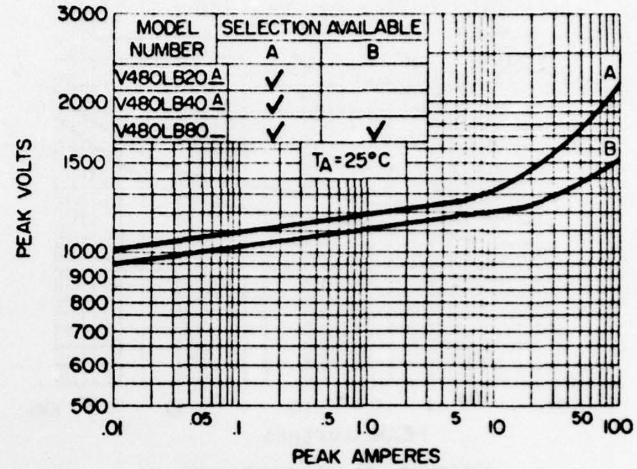


FIGURE 10. 480 VRMS PRODUCT

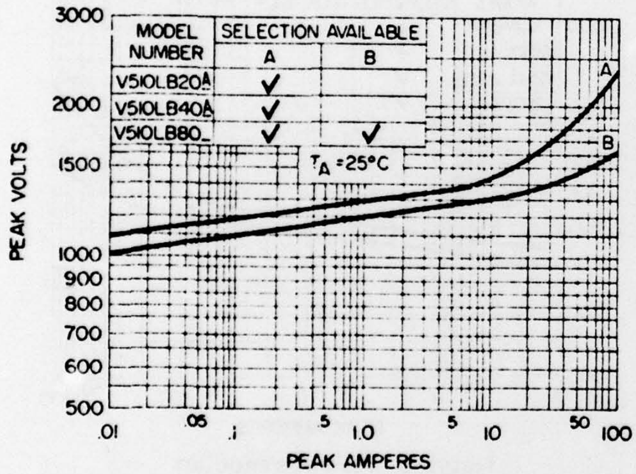


FIGURE 11. 510 VRMS PRODUCT

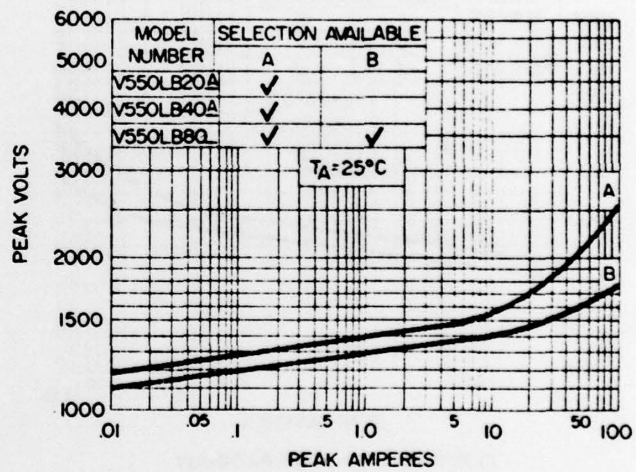


FIGURE 12. 550 VRMS PRODUCT

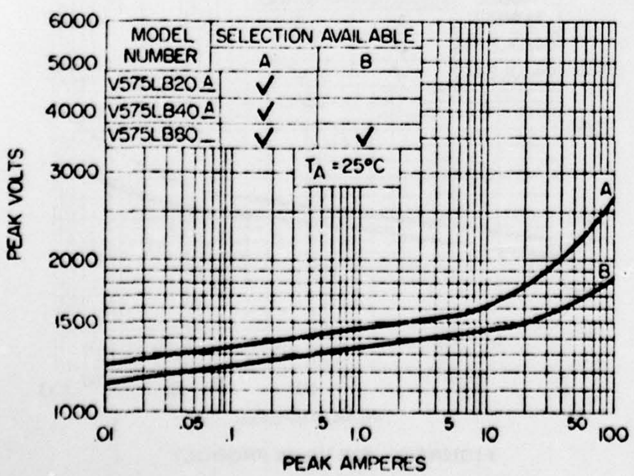


FIGURE 13. 575 VRMS PRODUCT

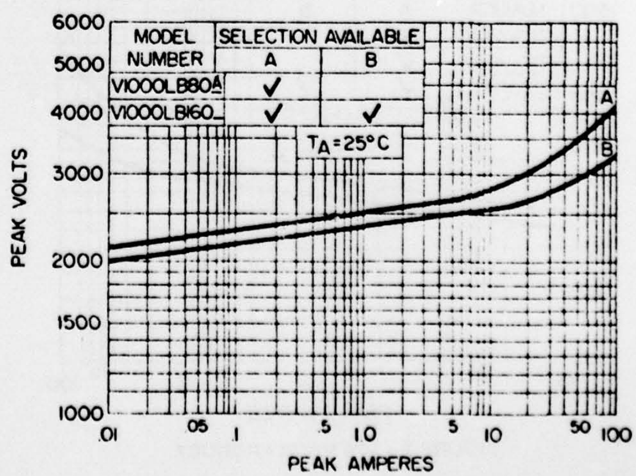


FIGURE 14. 1000 VRMS PRODUCT

Varistor Measurement Methods:

A charged coaxial line or other type of high energy pulse source such as the Velonex Pulse Generator – Model 350, is satisfactory for pulse testing. Care must be taken not to exceed the energy or power rating of the device under test. In addition, coaxial current shunts, such as those manufactured by T&M Research, and devices with leads as short as possible are recommended. The Tektronix 576 curve tracer can be used for 1–10 milliampere AC readings.

Velonex, Varian Division
560 Robert Avenue
Santa Clara, California 95050

T&M Research Products Inc.
129 Rhode Island, N.E.
Albuquerque, New Mexico 87108

Definition of Varistor Terms:

1. **Recurrent peak idle voltage.**

   The peak voltage that appears across the GE–MOV varistor terminals when no transient is present. This voltage should be the RMS line voltage $X\sqrt{2}$ (to obtain peak voltage) plus some factor to insure high line conditions (usually 10%).

   AC example: For a 220 VRMS system, the peak idle voltage would be
   220 X 1.414 X 1.10 = 342 VAC peak idle.

   DC example: For a 300 VDC system, the peak idle voltage would be
   300 X 1.10 = 330 VDC peak idle.

2. **Peak clamping voltage.**

   The peak voltage to which the transient voltage must be suppressed.

3. **Transient peak current.**

   Instantaneous peak current of the voltage transient.

4. **Transient pulse width.**

   The width of the transient spike in micro-seconds.

5. **Transient rep rate.**

   The number of transient pulses per second.

6. **Transient energy.**

   The available energy in Watt-seconds (joules).
   $\text{Energy} = 1/2\ LI^2 = 1/2\ CV^2 = I^2RT = VIT$
   (where T = pulse width in seconds).

7. **Ambient temperature.**

   Temperature in which the GE-MOV varistor will be operating. (°C)

8. **Clamp ratio.**

   $$CR = \frac{\text{Peak Clamping Voltage}}{\text{Recurrent Peak Idle Voltage}}$$

Application Notes:

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200.60	GE-MOV ™ VARISTORS VOLTAGE TRANSIENT SUPPRESSORS
200.71	USING GE-MOV ™ VARISTORS FOR THE SUPPRESSION OF VOLTAGE SURGES DUE TO THE SWITCHING OF INDUCTIVE LOADS
200.72	USING GE-MOV ™ VARISTORS TO EXTEND CONTACT LIFE
95.44	GE-MOV ™ VARISTOR RELIABILITY REPORT

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